#### VIRTUAL EVENT

# TestConX

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TestConX.org

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# Innovations in Package Testing of 5G mmWave Applications

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## Challenges

- Testing 5G devices at mmWave (55+ GHz)
- Calibration to the DUT
- Signal integrity with minimal loss from tester to DUT
- Implementation costs
- mmWave interfacing (cable "jungle")



## **Interceptor Technology**

- Interceptor concept
  - Intercepts the RF signals and routes the signals to bypass the loadboard
  - Integrates a small RF focused PCB into the contactor itself
  - Reduces the cost and complexity on the tester loadboard
  - Minimizes interfacing requirements
- 5G Interceptor contactor includes:
  - 55+ GHz switching for up to 32 channels
  - MIPI controller
  - ID tracking chip (Protrace)





#### **Interceptor Loadboard Assembly**



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₄ 2021

## **Enabling Technologies**

- 60GHz spring probes (cRacer)
- RF optimized PCB
  - Coaxial vias
  - Precision feature control
- Calibration substrates (DUT surrogates)
  - Optimized for each application
  - Measures the test system to allow de-embedding system parasitics
  - Open short load and configurable thrus





## **5G Interceptor: Part of Cohu 5G Test Cell**

#### • Performance

- Shortest fanout distance from source to DUT - lowest loss
- Shielded and low loss cables, switches connector, Interceptor, and contactor

#### Density

- 2.5mm RF cable pitch
  - Order of magnitude finer pitch
- Up to 32 RF pins per DUT

Test**ConX**®

- Universal
  - Generic socket board
  - Only Interceptor board customized for DUT
- Calibration
  - Cal substrate, calibration from tester to DUT

- Simplicity
  - Blind mate loadboard No cable routing jungle on back of loadboard
  - Low frequency laminate for socket board
- Cost
  - Minimized mmWave hardware
  - OEE test floor efficiency
  - Less time in calibration
  - Switch over time





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#### **Interceptor Construction**

#### • 55+ GHz



#### cRacer RF optimized contactor

#### Embedded RF fanout PCB

Standard spring probe interposer connects low frequency signals to loadboard



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### **Interceptor Construction**



- The embedded
  RF PCB
- Cal substrate
- Manual actuator

 Low loss optimized RF traces





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### **R&D Altanova: RF Coax Vias**

- "Tuned impedance vias" typically are only good to ~30 GHz
- Coax vias are good to 90 GHz
- 0.7dB of loss up at 50 GHz for 150 mil fine pitch via



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### **R&D Altanova: Precision Feature Control**

- High quality outer layer improved feature process
- RF structures require high quality outer layer structures
  - Low discontinuity RF transitions
  - Strong correlation between simulation and PCB
  - Allows for trace structures like Baluns, combiners, and filters







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## **Calibration Substrates**

#### 2 Calibration types

- Scalar calibration (magnitude only)
- Vector calibration (magnitude and phase)

#### • 3 Calibration methods

- 1. S-Parameter (provided by Cohu)
- 2. Known-Good ("Golden") Device (Customer provided)
- 3. OSLT Calibration Substrates
  - Open Short Load (OSL) or thru-reflect-line (TRL or thru) structures embedded on a DUT surrogate

#### Calibration substrates

- Provide most inclusive and accurate calibration
- Incorporate the entire signal chain from source to measure modules



xWave S-parameters are shipped with contactor on USB







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#### Performance

- Insertion loss shown on right is roundtrip through:
  - Interceptor PCB -> THRU Cal Substrate -> Interceptor PCB





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## **Summary / Conclusion**

- Interceptor supports 5G test strategies for any package type from 150 µm to 800 µm pitch
- Calibration substrates allow the tester to have a calibrated RF path to the device ball
- Signal integrity with minimal loss from tester to DUT
- Improved mmWave signal interface to the tester
- Eliminates the cable "jungle"
- Thank you to R & D Altanova for the opportunity and collaboration!



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# Cohu

The Market Leader in Test Interface Solutions for the Most Challenging Applications











Mobility

Precision Analog & Sensors

**High End Digital** 

Automotive & Power



RF



#### **ELASTOMET SOCKET & INTERPOSERS**

- High performance and competitive price
- High speed & RF device capability
- Various customized design to meet challenge requirement

#### **POGO SOCKET SOLUTIONS**

- Excellent gap control & long lifespan
- High bandwidth & low contact resistance

#### THERMAL CONTROL UNIT

- Extreme active temperature control
- Safety auto shut-down temperature monitoring of the device & thermal control unit
- Full FEA analysis & Price competitiveness

#### **BURN-IN SOLUTIONS**

- Direct inserting on the board without soldering
- Higher performance BIB solution









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#### WIN IWIN Co., Ltd.

#### The test probe for high signal integrity at extremely high speed test

#### Spring probe by stamping



250 kinds of spring probe pin

300 kinds of test socket (44,000 Pin count socket possible)

One piece spring probe

Three piece spring probe

High speed product → 0.63mm free length

spring probe pin available

Finest Pitch → 0.15mm Pitch





Spring probe by stamping

		Patented
Pitch(mm)	Free Length(mm)	Current Carrying(Amps)
0.15/0.2/0.25	2.17~	0.5~
0.3	1.5~	1.5~
0.35	2.08~	1.8~
0.4	0.8~	2.5~
0.5	1.5~	3.0~
0.65	1.13~	9.0~
0.8	3.14~	3.0~

#### Automation Pin assembly and Quality control





pins socket

Top Figure: Socket CRES, Force, Stroke test Bottom Figure: Data displayed

#### Socket and Lid



(by IWIN)



- Stamped piece parts attached to a

reel fed into the assembly machine

Bottom Figure: Data display 5,903

Pin assembly

(Fully automated machines)

#### Spring probe pins for High speed

#### Extremely short spring probes by stamping





One piece spring prob **Design approach** 

0.50

00.32





Insertion Loss - HPSP28063F1-01



Return Loss - HPSP28063F1-01 0.00 -10.00 62.01GHz -20.00 -30.00 -40.00 -50.00 Curve Info dB(St(Dim),Dim)) -60.00 -70.00 0.00

### SOLUTION

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#### **High Performance Probe solution**

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